the sustainability of resident native fish species. The San Joaquin River is a low elevation, valley floor river (Moyle and Ellison 1991). The quality of freshwater fish habitat in the San Joaquin River will be maintained through actions directed at streamflows, sediment supply, stream meander, natural floodplain and flood processes, maintaining and restoring riparian and riverine aquatic habitats, and reducing the adverse effects of stressors such as contaminants.

AGRICULTURAL LANDS: Improving habitats on and adjacent to agricultural lands in the Butte Basin Ecological Management Zone will benefit native waterfowl and wildlife species. Emphasizing certain agricultural practices (e.g., winter flooding and harvesting methods that leave some grain in the fields) will also benefit many wildlife that seasonally use these important habitats.

VISIONS FOR REDUCING OR ELIMINATING STRESSORS

WATER DIVERSIONS: The vision for water diversions is that the diversion of water from the lower San Joaquin River will not adversely influence efforts to rebuild fish populations and maintain riparian and riverine aquatic habitats.

LEVEES, BRIDGES, AND BANK PROTECTION: Levees, bridges, and bank protection measures along the San Joaquin River have inhibited overland flow and erosion and depositional processes that develop and maintain the floodplain. The vision is to modify, remove, or reoperate structures in a manner that greatly lessens adverse affects on ecological processes and aquatic organisms.

CONTAMINANTS: The vision is to reduce losses of fish and wildlife due to pesticide, hydrocarbon, heavy metal, and other pollutants.

VISIONS FOR SPECIES

CHINOOK SALMON: The vision for chinook salmon is to recover all stocks presently listed or proposed for listing under ESA or CESA, achieve naturally spawning population levels that support and maintain ocean commercial and ocean and inland recreational fisheries, and that use fully existing and restored habitats. The vision is that improved habitats and flows in the San Joaquin River below the mouth of the Merced River will contribute to the survival of adult and juvenile chinook salmon.

STEELHEAD: The vision for steelhead trout is to recover this species listed as threatened under the ESA and achieve naturally spawning populations of sufficient size to support inland recreational fishing and that use fully existing and restored habitat.

SPLITTAIL: The vision for splittail is to achieve recovery of this federally listed threatened species. The vision is that splittail will have access to seasonally flooded spawning habitat and that their offspring will have unimpaired access to rearing and foraging areas.

WHITE STURGEON: The vision for white sturgeon is to maintain and restore population distribution and abundance to historical levels. Improved flows in late winter and early spring will benefit sturgeon spawning. Improved stream meander corridors should also benefit sturgeon. The vision is that restoration of ecological processes and habitats along with a reduction of stressors will contribute to stable and larger sturgeon populations.

AMERICAN SHAD: The vision for American shad is to maintain a naturally spawning population, consistent with restoring native species, that supports a sport fishery similar to the fishery that existed in the 1960s and 1970s.

LAMPREY: The vision for river lamprey is to maintain the diversity, distribution and abundance of this species.

WESTERN POND TURTLE: The vision for the western pond turtle is to maintain and restore their abundance and distribution by maintaining or expanding existing populations by improving stream channel, floodplain riparian processes, and reducing predator species.

GIANT GARTER SNAKE: The vision for the giant garter snake is to contribute to the recovery of this State and federally listed threatened species in order to contribute to the overall species richness and diversity. Achieving this vision will reduce the conflict between protection for this species and other beneficial uses of land and water in the Bay-Delta. Protecting existing and restoring additional suitable wetland and upland habitats will be critical to achieving recovery of the giant garter snake. The proposed restoration of aquatic, wetland, and riparian habitats in the East San Joaquin Ecological

Management Zone will help in the recovery of these species by increasing habitat quality and area.

SWAINSON'S HAWK: The vision for Swainson's hawk is to contribute to the recovery of this State-listed threatened species. Improvements in riparian and agricultural wildlife habitats will aid in the recovery of the Swainson's hawk. Increased abundance and possibly some nesting would be expected as a result of improved habitat.

GREATER SANDHILL CRANE: The vision for the greater sandhill crane is to contribute to the recovery of this California species of special concern. Improvements in pasture lands and seasonally flooded agricultural habitats, such as flooded corn fields, should help toward recovery of the greater sandhill crane population. The population should remain stable or increase with improvements in habitat.

WESTERN YELLOW-BILLED CUCKOO: The vision for the western yellow-billed cuckoo is to contribute to the recovery of this State-listed endangered species. The yellow-billed cuckoo along the San Joaquin River and its tributaries is not a species for which specific restoration projects are proposed. Potential habitat for the cuckoo will be expanded by improvements in riparian habitat areas. These improvements will result from efforts to protect, maintain, and restore riparian and riverine aquatic habitats throughout the San Joaquin River and East San Joaquin Ecological Management Zones, thus sustaining the river meander belt, and increasing the natural sediment supply to support meander and riparian regeneration.

SHOREBIRDS AND WADING BIRDS: The vision for the shorebird and wading bird guilds is to maintain and restore healthy populations through habitat protection and restoration. Shorebirds and wading birds will benefit from restoration of wetland, riparian, aquatic, and agricultural habitats. The extent of seasonal use of the East San Joaquin Ecological Management Zone by these birds should increase.

WATERFOWL: The vision for waterfowl is to maintain and restore healthy populations at levels that can support consumptive (e.g., hunting) and nonconsumptive (e.g., birdwatching) uses. Many species of resident and migratory waterfowl will benefit from improved aquatic, wetland, riparian, and agricultural habitats. Increase use of the East San Joaquin Ecological Management Zone and possibly increases in some populations would be expected.

NEOTROPICAL MIGRATORY BIRDS: The vision for the neotropical migratory bird guild is to restore and maintain healthy populations of neotropical migratory birds through restoring habitats on which they depend. Protecting existing and restoring additional suitable wetland, riparian, and grassland habitats will be critical to maintaining healthy neotropical migrant bird populations in the Bay-Delta.

RIPARIAN BRUSH RABBIT: The vision for the riparian brush rabbit is to contribute to the recovery of this federally and State-listed endangered species through improvements in riparian habitat and reintroduction to former habitat.

SAN JOAQUIN VALLEY WOODRAT: The vision for the San Joaquin Valley woodrat is to contribute to the recovery of this federally listed endangered species through improvement in its habitat.

NATIVE RESIDENT FISHES: The vision for native resident fish species is to maintain and restore the distribution and abundance.

PLANT SPECIES AND COMMUNITIES: The vision for plan species and communities is to protect and restore these resources in conjunction with efforts to protect and restore wetland and riparian and riverine aquatic habitats.

INTEGRATION WITH OTHER RESTORATION PROGRAMS

The Ecosystem Restoration Program (ERP) proposes targets and actions for the San Joaquin River Ecological Management Zone to augment other current and future restoration efforts for the zone.

SAN JOAQUIN RIVER MANAGEMENT PROGRAM

The San Joaquin River Management Program was established through State legislation (Chapter 1068/90) to develop comprehensive and compatible solutions to water supply, water quality, flood control, fisheries, wildlife habitat, and recreational needs in the San Joaquin River basin.

Central Valley Project Improvement Act

Section 3406(c) of the Central Valley Project Improvement Act directed the Secretary of the Interior to develop a comprehensive plan to address fish, wildlife, and habitat concerns on the San Joaquin River. The vision for the San Joaquin River Ecological Management Zone will also complement efforts of the U.S. Fish and Wildlife Service (USFWS) Anadromous Fish Restoration Program. The goal of the program is to double the natural production of anadromous fish in the system over average production during 1967 through 1991.

CALFED Bay-Delta Program

CALFED has funded eight ecosystem restoration projects in the San Joaquin River Ecological Management Zone. One project acquires and restores 6,169 acres of land along the San Joaquin River to be incorporated into the San Joaquin River National Wildlife Refuge. Another project studies the use of bacteria to reduce selenium in agricultural drain water.

Salmon, Steelhead Trout and Anadromous Fisheries Program Act

Established in 1988 by Senate Bill 2261, this Act directs the California DFG to implement measures to double the numbers of salmon and steelhead present in the Central Valley (DFG 1993, 1996). The DFG's salmon and steelhead restoration program includes cooperative efforts with local governments and private landowners to identify problem areas and to assist in obtaining funding for feasibility studies, environmental permitting, and project construction. The ERP vision for this Ecological Management Zone will also assist DFG as it progresses toward its goal of doubling the number of anadromous fish over 1988 population levels.

Sacramento-San Joaquin River Basins Comprehensive Study

This study proposes coordination between the U.S. Army Corps of Engineers (Corps), USFWS, California Department of Water Resources (DWR), and other participating agencies to review and reevaluate the San Joaquin River flood control system in light of the inadequate capacity demonstrated by the 1997 floods, and consistent with floodplain habitat recommendations contained in the 1995 San Joaquin River Management Plan. Emphasis will be placed on managing the floodplain and detaining floodflows to meet safety, infrastructure reliability, and habitat objectives, along with reconstructing and upgrading existing levees.

Agreement on San Joaquin River Protection

In an effort to resolve issues brought forth in the State Water Resources Control Board's 1995 Water Quality Control Plan for the Bay/Delta, the San Joaquin River Tributaries Association, San Joaquin River Exchange Contractors Water Authority, Friant Water Users Authority, and the San Francisco Public Utilities Commission collaborated to identify feasible, voluntary actions to protect the San Joaquin River's fish resources. In spring 1996, these parties agreed on a "Letter of Intent to Resolve San Joaquin River Issues." This agreement, when finalized, has the potential of providing the following:

- higher minimum base flows,
- significantly increased pulse flows,
- installation and operation of a new fish barrier on the mainstem San Joaquin River,
- set up a new biological monitoring program, and
- set aside federal restoration funds to cover costs associated with these measures.

One of the important components of the Agreement is the development of the Vernalis Adaptive Management Program (VAMP) to improve environmental conditions on the San Joaquin River. Elements of this potential adaptive management program include a range of flow and non-flow habitat improvement actions throughout the watershed, and an experimental program designed to collect data needed to develop scientifically sound fishery management options for the future.

The future of the Agreement is unknown at this time. However, several actions by the San Joaquin River Stakeholders Policy Group and other parties have been or are presently being implemented throughout the watershed. These actions include:

- Increased flow from the Tuolumne River, and implementation of non-flow programs through a settlement between the Federal Energy Regulatory Commission and numerous other parties;
- An interim operating plan for the New Melones Project to provide additional flows on the Stanislaus River;
- New fishery response test programs on the Merced River;
- Actions by water users on the Stanislaus and Merced rivers to sell water purchase options that would help meet Central Valley Project Improvement Act objectives;
- Salmon smolt out-migration studies conducted by Oakdale Irrigation District, South San Joaquin Irrigation District, USFS, and DFG on the Stanislaus River;
- A two-year water purchase by USBR from Oakdale Irrigation District and South San Joaquin Irrigation Districts of up to 50,000 acre-feet to help implement fish-doubling objectives of the Central Valley Project Improvement Act; and
- Seasonal installation of a fish barrier at the head of Old River for a five-year period.

SAN JOAQUIN RIVER RIPARIAN HABITAT RESTORATION PROJECT

The San Joaquin River Riparian Habitat Restoration Project is a collaborative effort of the Friant Water Users Authority, the Natural Resources Defense Council, the Pacific Coast Federation of Fishermen's Associations, U.S. Bureau of Reclamation, U.S. Fish and Wildlife Service, with participation by other local and state interests, who share a strong interest in the mainstem of the San Joaquin River. The group agreed to pursue mutually acceptable restoration activities and initially will focus on riparian habitat restoration along the San Joaquin River from Friant Dam to the confluence with the Merced River. There are many benefits to developing and implementing a riparian restoration plan, including improved flood control, groundwater recharge, and fish and wildlife enhancement. Other projects may be pursued as consensus is reached.

Riparian restoration may take a variety of forms and the project will be developed to ensure that it is consistent with other goals and objectives established for the San Joaquin River. This is a stakeholder driven project that will need the assistance of all the interested parties and the public.

In October 1998, the Program reported an analysis of the affects of physical processes on the potential for riparian habitat on the San Joaquin River from Friant Dam to the confluence of the Merced River. They reported that natural physical processes affecting the river and riparian vegetation included surface and groundwater hydrology, bank and bed erosion and deposition, channel and floodplain hydraulics and sediment transport, and other channel-forming processes. The timing, pattern, and magnitude of these natural physical processes have been altered by local and state flood control projects, operation of reservoir dams and weirs, reclamation of the river floodplain and basin lands for agricultural and urban uses, and mining of sand and gravel from channel deposits.

CENTRAL VALLEY HABITAT JOINT VENTURE

The Central Valley Habitat Joint Venture and the North American Waterfowl Management Plan have developed objectives for wetlands in the San Joaquin River Ecological Management Zone. These objectives are consistent with the ERP targets developed for this Ecological Management Zone.

LINKAGE TO OTHER ECOLOGICAL MANAGEMENT ZONES

Restoring and maintaining important ecological processes and functions in the San Joaquin River Ecological Management Zone depends on conditions in both the main tributaries to the river (the East San Joaquin Basin Ecological Management Zone) and the downstream Sacramento-San Joaquin Delta Ecological Management Zone. Water, sediment, nutrient supply, and input of contaminants from tributary streams all influence habitat conditions in the mainstem San Joaquin River. Changes in these factors from historical conditions have degraded habitat on the mainstem river. Maintaining a healthy riparian zone and balanced sediment budget in the

mainstem San Joaquin River will depend on an appropriate input of nutrients, water, and sediment from the major tributaries. Water supply from the tributaries is critical to maintaining aquatic habitat in the mainstem river between the Merced River confluence and Vernalis because Friant Dam diverts almost all the flow from the upper San Joaquin River watershed.

The Sacramento-San Joaquin Delta Ecological Management Zone provides habitat for upstream migration of adult anadromous fish and downstream migration and rearing of juvenile anadromous fish from the San Joaquin River basin. Conditions in the Delta have a significant effect on anadromous fish production in the San Joaquin River basin because, in most years, a significant proportion of inflow from the basin is diverted at the Delta and entrainment losses of juveniles are high. In turn, the volume of inflow and the input of nutrients, contaminants, and sediments from the San Joaquin River significantly affect the health of the Delta ecosystem. Restoring and maintaining a healthy ecosystem in this zone will be critical to ecosystem restoration in the Delta.

Although delta smelt (federally listed as threatened) do not inhabit the San Joaquin River Ecological Management Zone, flows from this zone have significant effects on habitat for the species in the Delta. Delta smelt spawn in different locations in the Delta each year. Some always spawn on the San Joaquin side of the Delta; however, and sometimes hydrologic conditions cause larvae and juveniles to move from the Sacramento to the San Joaquin side. In the 1995 USFWS biological opinion for delta smelt, year-round base flows and April and May flows from the San Joaquin River are specified to protect delta smelt. The biological opinion also states that contaminants entering the Delta from the San Joaquin River likely affect delta smelt and its food organisms, as well as juvenile chinook salmon and striped bass.

Additionally, stressors affecting fish and wildlife species that use the San Joaquin River during at least part of their life cycle occur outside the identified Ecological Management Zones. For example, ocean recreational and commercial fisheries have a significant effect on the numbers of anadromous fish returning to spawn and rear in the San Joaquin River basin. New harvest management strategies for ocean fisheries may be needed in addition to restoration work inland.

RESTORATION TARGETS AND PROGRAMMATIC ACTIONS

ECOLOGICAL PROCESSES

CENTRAL VALLEY STREAMFLOWS

TARGET 1: Manage flow releases from tributary streams to provide adequate upstream and downstream passage of fall-run and late-fall-run chinook salmon, resident rainbow trout, and steelhead and spawning and rearing habitat for American shad, splittail, and sturgeon from the Merced River confluence to Vernalis (◆◆).

PROGRAMMATIC ACTION 1A: Develop a cooperative program to purchase water from willing sellers or develop alternative sources of water.

TARGET 2: Manage flow releases from Friant Dam to Gravelly Ford to maintain sustainable populations of resident native fish (◆◆).

PROGRAMMATIC ACTION 2A: Evaluate the feasibility of increasing flows below Friant to restore terrestrial and aquatic habitats for fish and wildlife including anadromous salmonids.

TARGET 3: Optimize the ecological value of wet year flood releases below Friant Dam (◆◆).

PROGRAMMATIC ACTION 3A: Evaluate the feasibility of modifying flood operation guidelines and schedules in wet years to include more variable hydrographs with higher peak flows of shorter duration and more overall flow variability.

RATIONALE: *Flows in the major eastside tributaries to the San Joaquin River (Stanislaus, Tuolumne, and Merced rivers) are controlled by releases from foothill storage reservoirs (New Melones, New Don Pedro, and New Exchequer reservoirs, respectively). Flows from the mainstem San Joaquin River are controlled by Friant Dam. The significant reduction in outflow from the San Joaquin River caused by water development in the basin has significantly reduced production of chinook salmon in the basin. Increasing base-flow releases from the tributary reservoirs would increase habitat in the mainstem San Joaquin River for rearing and for upstream and downstream migration of fall-run and late-fall-run chinook*

salmon, rainbow trout, and steelhead and for spawning and rearing habitat of American shad, white and green sturgeon, and splittail from the Merced River confluence to Vernalis.

Escapement of chinook salmon in the San Joaquin River basin appears to be strongly improved by high April through June flows at Vernalis and low exports during the year of outmigration (California Department of Fish and Game 1992, 1993; Carl Mesick Consultants 1994). Based on this relationship, the USFWS (1995) recommended base flows for Vernalis by water-year type to meet the goals of the Anadromous Fish Restoration Program.

Flows from Friant Dam to Gravelly Ford should be managed to maintain native resident fish populations until an evaluation of the potential to restore anadromous salmonids is completed.

Natural stream-meander belts in alluvial systems transport and deposit sediments and provide transient habitats important to algae, aquatic invertebrates, and fish, as well as substrates (surfaces on which plants and animals can live) for colonization by riparian vegetation.

Present flood operations below Friant Dam typically result in uniform flows for long durations during the winter and spring months. Providing a more variable hydrograph which emulated natural inflow patterns to Millerton Lake would increase habitat complexity and diversity, mobilize bar material, and create better seed dispersal and more favorable sites for colonization by riparian species. A particular emphasis should be placed on flow peaks during at least portions of the early spring months when seed of cottonwood and sycamore trees is being dispersed in the river. The purchase of easements or fee title on lands that become subject to greater flood frequency from peak overbank flows could be used to expand the area of low floodplain along the river to be colonized naturally or planted with riparian vegetation (San Joaquin River Riparian Habitat Restoration Program 1998).

COARSE SEDIMENT SUPPLY

TARGET 1: Restore existing natural sources of coarse sediments below Friant Dam (◆◆◆).

PROGRAMMATIC ACTION 1A: Develop a cooperative incentive program to relocate gravel mining operations from the active floodplain.

RATIONALE: *Dry Creek enters the river below Friant Dam and is the only remaining tributary that supplies a significant source of coarse sediments with high flows. Bedload entering the river from Dry Creek during high flows reduces the tendency of the channel to incise and forms shifting river deposits on bars that are needed for riparian colonization and succession to occur.*

STREAM MEANDER

TARGET 1: Restore and maintain a defined stream-meander zone on the San Joaquin River between Vernalis and the mouth of the Merced River (◆◆◆).

PROGRAMMATIC ACTION 1A: Develop a cooperative strategy to acquire or obtain easements on floodplain and riparian land.

PROGRAMMATIC ACTION 1B: Establish a river meander corridor between the Chowchilla Bypass and Mendota Pool.

RATIONALE: *Preserving and improving the stream meander belt below the mouth of the Merced River will ensure that this important natural process is maintained in the San Joaquin River. This reach is important for migrating and rearing salmon and steelhead and other anadromous and resident fish species. A natural meander process will provide excellent habitat for spawning (through gravel recruitment), rearing (channel form, cover, and foodweb), and migration. The stream channel meander program must be consistent with flood control requirements and, in the longer term, should reduce the need for future flood control efforts by using natural system resilience and flood control characteristics.*

The river between Chowchilla Bypass and Mendota Pool has the highest sinuosity and a greater tendency for bank migration, bendway cutoffs, and overbank flow across meander bends. The suggested approach to restoring meander in this section allows river bends to migrate within a designated meander corridor and allows high flows to overtop the large point bars. These alluvial processes will promote the regeneration of riparian vegetation and overall habitat complexity.

NATURAL FLOODPLAIN AND FLOOD PROCESSES

TARGET 1: Restore floodplain-river interactions in the San Joaquin River between Vernalis and the mouth of the Merced River (◆◆◆).

PROGRAMMATIC ACTION 1A: Develop a cooperative program to evaluate the potential for levee deauthorization, levee removal, or levee setbacks.

PROGRAMMATIC ACTION 1B: Develop a cooperative strategy to acquire or obtain easements or ownership of floodplain along the lower San Joaquin River.

PROGRAMMATIC ACTION 1C: Conserve remaining natural floodplain topography and sloughs.

RATIONALE: *Setback levees will provide more floodplain flooding, room for stream meander, and more riparian forest and seasonal wetland habitats along the lower San Joaquin River. Channel form adjustments may be necessary to accelerate restoration of natural floodplain habitats and to restore and maintain configurations that may not occur naturally due to remaining constraints from the new setback levees. Permanent structures such as bridges and diversions dams can interrupt and impair natural floodplain processes and habitat development and succession, thus requiring removal of the structures, rebuilding, or some continuing maintenance or mitigation to minimize their effects.*

Major flood flows along the San Joaquin River periodically exceed flow capacity within the river levees, causing local and regional flooding. Even lesser flows can result in seepage damage to levees and lands adjacent to the floodway. The U.S. Army Corps of Engineers investigated the potential for a demonstration project for distributing peak flood flows over land on wildlife refuges adjacent to the river. A previous analysis of the West Bear Creek Floodplain Restoration Project was a joint effort by the U.S. Fish and Wildlife Service and the California Department of Water Resources using the San Joaquin Basin Action Plan interagency agreement and the San Joaquin River Management Program funding. Recently, the CALFED Category III restoration program provided funding to the USFWS to conduct a feasibility study for this floodplain restoration program.

Large areas of the historic floodplain still support natural topography and sloughs on both sides of the levee network, while other areas have been laser leveled for irrigated agriculture or managed wetlands. The potential for rewetting the floodplain varies by reach, based on the changes in bankfull channel capacity and the magnitude of the reduction of flow under present hydrology. Many areas would derive ecological benefits from the reintroduction of managed or natural overbank flows, generally within a range of average annual to 10-year frequency inundation (San Joaquin River Riparian Habitat Restoration Program 1998).

CENTRAL VALLEY STREAM TEMPERATURES

TARGET 1: Manage reservoir releases and other factors to provide suitable water temperatures for important resources from the Merced River confluence to Vernalis (◆◆).

PROGRAMMATIC ACTION 1A: Evaluate the feasibility of releasing sufficient instream flows to improve the temperature regime for important resources.

PROGRAMMATIC ACTION 1B: Evaluate the use of upstream temperature control devices and reservoir management options to reduce water temperatures during critical periods.

PROGRAMMATIC ACTION 1C: Develop a cooperative program to evaluate the potential for restoring riparian vegetation to reduce water temperatures.

PROGRAMMATIC ACTION 1D: Develop a cooperative program to evaluate the impact of discharge returns on stream temperature.

RATIONALE: *Water temperatures in the mainstem San Joaquin River between the Merced River confluence and Vernalis in the fall and spring often exceed stressful or lethal levels for upstream and downstream migrating fall-run chinook salmon. High temperatures are thought to delay migration in the fall (DFG 1992) and increase mortality of rearing and outmigrating juveniles in the spring (DFG 1993). When the Vernalis flow is 5,000 cfs or less in May, water temperatures are at levels of chronic*

stress. Maintenance of improved base flows in the fall and spring will increase survival of up and downstream migrating chinook salmon.

HABITATS

SEASONAL WETLANDS

TARGET 1: Assist in protecting 52,500 acres of existing seasonal wetland habitat through fee acquisition or perpetual easements consistent with the goals of the Central Valley Habitat Joint Venture and the North American Waterfowl Management Plan (◆◆).

PROGRAMMATIC ACTION 1A: Develop and implement a cooperative program to improve management of 52,500 acres of existing, degraded seasonal wetland habitat.

TARGET 2: Develop and implement a cooperative program to enhance 120,300 acres of existing public and private seasonal wetland habitat consistent with the goals of the Central Valley Habitat Joint Venture and the North American Waterfowl Management Plan (◆◆).

PROGRAMMATIC ACTION 2A: Improve and manage seasonal wetland habitat throughout the Ecological Management Zone.

RATIONALE: *Restoring seasonal wetland habitats along with aquatic, permanent wetland, and riparian habitats is an essential element of the restoration strategy for the Joaquin Ecological Management Zone. Restoring these habitats will also reduce the amount and concentrations of contaminants that could interfere with restoring the ecological health of the aquatic ecosystem. Seasonal wetlands support a high production rate of primary and secondary food species and large blooms (dense populations) of aquatic invertebrates.*

Wetlands that are dry in summer are also efficient sinks for the transformation of nutrients and the breakdown of pesticides and other contaminants. The roughness of seasonal wetland vegetation filters and traps sediment and organic particulates. Water flowing out from seasonal wetlands is typically high in foodweb prey species concentrations and fine particulate organic matter that feed many Delta aquatic and semiaquatic fish and wildlife. To capitalize on these functions, most of the seasonal wetlands of the San Joaquin Ecological Management Zone should be subject to periodic flooding and overland flow from river floodplains.

RIPARIAN AND RIVERINE AQUATIC HABITATS

TARGET 1: Restore 50 stream miles (1,212 acres) of diverse, self-sustaining riparian community (◆◆◆).

PROGRAMMATIC ACTION 1A: Develop a cooperative program to protect large remnant stands of old growth riparian woodlands.

PROGRAMMATIC ACTION 1B: Develop a cooperative program to restore riparian habitat.

PROGRAMMATIC ACTION 1C: Improve land management and livestock grazing practices along streams and riparian zones.

TARGET 2: Revegetate low floodplains formerly cleared for agricultural purposes or during past floodway clearing projects (◆◆).

PROGRAMMATIC ACTION 2A: Identify potential revegetation sites that are subject to inundation at least every 5-10 years.

RATIONALE: *Because of high-flow-event reduction, stream channelization, livestock grazing, gravel extraction, and direct loss of habitat to agriculture and urban development; the extent of riparian vegetation along the mainstem San Joaquin River has been significantly reduced. Before they were disturbed, riparian forests were an important component of the mosaic of habitats in the San Joaquin Valley, providing habitat for a variety of native wildlife species. The riparian community provides nutrients and woody debris to the aquatic system, along with shade and increased bank stability. The importance of restoring riparian habitat has been identified by DFG (1993) and USFWS (1997).*

Old-growth stands of cottonwood forest, sycamore and valley oak woodlands, and wooded grassland savanna are scattered throughout the area. Some of these stands occur within State and federal refuges or parks, while others are found on private lands. Landowners at these sites should be contacted to determine if the old growth sites are secure under existing land management practices or if special conservation easements or management plans are

needed to ensure the long-term survival of these unique relict-age classes and their wildlife habitat and aesthetic values (San Joaquin River Riparian Habitat Restoration Program 1998).

There are also many sites along the San Joaquin River where low floodplains along the channel are subject to infrequent inundation every 5-10 years. The Corp's comprehensive new hydraulic model of the entire river and bypass system may reveal segments of designated floodways where actual capacity exceed design capacity and can therefore safely convey large flood events, even with an increase in channel roughness. In other instances, forest may have been cleared within a meander corridor for agricultural use, though many sites on agricultural fields appeared in aerial photos to be abandoned. Planted species mixes should conform to the vertical range of cohorts in the general vicinity of the river corridor (San Joaquin River Riparian Habitat Restoration Program 1998).

FRESHWATER FISH HABITAT

TARGET 1: Maintain and improve existing freshwater fish habitat through the integration of actions described for ecological processes, habitats, and stressor reduction or elimination (◆◆).

PROGRAMMATIC ACTIONS: No additional programmatic actions are recommended.

RATIONALE: *Freshwater fish habitat is evaluated in terms of its quality and quantity. Actions described for San Joaquin River ecological processes, stressor reduction, and riparian and riverine aquatic habitat should suffice to maintain and restore freshwater fish habitats. For example, maintaining freshwater fish habitats is governed by actions to maintain streamflow, improve coarse sediment supplies, maintain stream meander, maintain or restore connectivity of the San Joaquin River and its floodplain, and in maintaining and restoring riparian and riverine aquatic habitats.*

AGRICULTURAL LANDS

TARGET 1: Cooperatively enhance 15,290 acres of private agricultural land to support nesting and wintering waterfowl consistent with the objectives of the Central Valley Habitat Joint Venture and the North American Waterfowl Management Plan (◆◆).

PROGRAMMATIC ACTION 1A: Increase the area of rice fields and other crop lands flooded in winter and spring to provide high-quality foraging habitat for wintering and migrating waterfowl and shorebirds and associated wildlife.

RATIONALE: *Following the extensive loss of native wetland habitats in the Central Valley, some wetland wildlife species have adapted to the artificial wetlands of some agricultural practices and have become dependent on these wetlands to sustain their populations. Agriculturally created wetlands include rice lands; fields flooded for weed and pest control; stubble management; and tailwater circulation ponds.*

Managing agricultural lands to increase forage for waterfowl and other wildlife will increase the survival rates of overwintering wildlife and strengthen them for migration, thus improving breeding success.

Creating small ponds on farms with nearby waterfowl nesting habitat but little brood habitat will increase production of resident waterfowl species when brood ponds are developed and managed properly. Researchers and wetland managers with the DFG, U.S. Fish and Wildlife Service and the California Waterfowl Association have found that well managed brood ponds produce the high levels of invertebrates needed to support brooding waterfowl. Other wildlife such as the giant garter snake will also benefit. Restoring suitable nesting habitat near brood ponds will increase the production of resident waterfowl species.

REDUCING OR ELIMINATING STRESSORS

WATER DIVERSIONS

TARGET 1: Reduce entrainment of fish and other aquatic organisms into diversions by 50%, by volume, from the Merced River confluence to Vernalis (◆◆◆).

PROGRAMMATIC ACTION 1A: Develop a cooperative approach to install state-of-the-art fish screens at El Solyo, Patterson, and West Stanislaus Irrigation District diversions.

PROGRAMMATIC ACTION 1B: Develop a cooperative program to evaluate the feasibility of installing state-of-the-art screens on small and medium-sized diversions.

TARGET 2: Eliminate the loss of adult fall-run chinook salmon straying into the San Joaquin River upstream of the Merced River confluence (◆◆◆).

PROGRAMMATIC ACTION 2A: Continue annually installing a temporary weir on the San Joaquin River immediately upstream from the confluence with the Merced River to block adult salmon migration.

RATIONALE: *Three large water diversions are between the Merced River confluence and Vernalis on the mainstem San Joaquin River: El Solyo, West Stanislaus, and Patterson Irrigation District diversions. Fish screens were installed at these diversions in the late 1970s; however, because of the scarcity of returning salmon, the inappropriate design and inefficiency of the screens, and the high cost of maintenance; the screens were abandoned within a few years. Together, these diversions can withdraw a significant portion of the mainstem riverflow, particularly during dry water years. Irrigation diversions take place during the juvenile salmon outmigration. In addition, many, small or medium-sized diversions are on this reach of the San Joaquin River.*

In recent years, drainage practices in western Merced County have increased agricultural return flows from Salt and Mud Sloughs into the mainstem San Joaquin River. These flows attract significant numbers of adult salmon into the sloughs and, subsequently, into irrigation canals where no spawning habitat is available (DFG 1993). In fall 1991, 31% of the run in the San Joaquin River basin is estimated to have strayed into westside canals. In the late 1980s, DFG established an adult trapping station at Los Banos Wildlife Refuge at which eggs were taken for rearing at the Merced River Fish Facility. In fall 1992, DFG installed a temporary electrical barrier across the mainstem San Joaquin River immediately upstream from the confluence with the Merced River; this was extremely effective in blocking fish passage into the westside irrigation canals. Since then, a temporary weir has been installed at the site annually, and this has also been effective in blocking passage.

LEVEES, BRIDGES, AND BANK PROTECTION

TARGET 1: Set back 10 miles of levees along the San Joaquin River between the Merced River confluence and Vernalis where feasible to reestablish the hydrologic connectivity between these channels and natural floodplains (◆◆).

PROGRAMMATIC ACTION 1A: Develop a cooperative strategy to evaluate the potential for levee deauthorization or relocation.

PROGRAMMATIC ACTION 1B: Develop a cooperative program to acquire or obtain easements on floodplain and riparian land needed to meet restoration goals.

RATIONALE: *Natural stream meander belts in alluvial systems function to transport and deposit sediments and provide transient habitats important to algae, aquatic invertebrates, and fish, as well as providing substrates for colonization by riparian vegetation. Setting back levees along the San Joaquin River encourages natural stream meander and flooding processes.*

This measure includes removing site-specific local levees or deauthorizing unneeded segments of state levees to expand the area of flood basin and floodplain inundation. Additional information is needed to make these determinations. Each site-specific project will require a subreach hydraulic model and sediment transport analysis to evaluate the feasibility of breaching or removing levees or constructing controlled release weirs to restore periodic inundation of the flood basin and rewater formerly abandoned channels outside existing levees (San Joaquin River Riparian Habitat Restoration Program 1998).

INVASIVE RIPARIAN PLANTS

TARGET 1: Eradicate or suppress populations of exotic, invasive trees and shrubs (◆◆).

PROGRAMMATIC ACTION 1A: Evaluate and implement effective new techniques to control invasive plant species that combine low-impact, mechanical removal or prescribed fire with low concentrations of selective herbicides.

RATIONALE: *Expansions of giant reed (Arundo), tamarisk, and eucalyptus in some river segments threatens riparian habitat diversity and quality. Because of their growth characteristics, expansion of these invasive, non-native species will reduce channel floodway capacity and increase bank stability. The recommended action would involve a program to map and monitor the distribution of these harmful*